

NATIONAL BUREAU OF STANDARDS

March/1969

Technical News Bulletin

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TECHNICAL BULLETIN



U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

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Technical
News
Bulletin

MARCH 1969/VOL. 53, NO.3/ISSUED MONTHLY



U.S. DEPARTMENT OF COMMERCE

Maurice H. Stans, Secretary

NATIONAL BUREAU OF STANDARDS

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COVER: Flames lick about a specimen in an investigation of the combustible properties of aircraft interior materials. (See page 51.)

Prepared by the NBS Office of Technical Information and Publications, Washington, D.C. 20234

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology
- Center for Radiation Research
- Center for Computer Sciences and Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription: Domestic, \$3; foreign, \$4; single copy, 30 cents. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (June 22, 1966).

Library of Congress Catalog Card Number: 25-26527



J. J. Loftus (left) puts a specimen in a holder for a test of its smoke and gaseous production properties, while D. Gross checks an indicator tube for the gaseous concentrations of a previously burned specimen.

COMBUSTIBLE PROPERTIES of Aircraft Cabin Materials

REGULATIONS THAT SPECIFY THE USE of flame-resistant materials to reduce the potential fire hazard of transport-aircraft interior materials have been in effect for several years. No requirements exist, however, governing the quantity of smoke and gases released in the burning of these materials. As smoke and gases may be a factor in the accident-fire situation, information on these characteristics of aircraft materials has been needed to further define fire safety standards.

To supply these data, the Institute for Applied Technology recently made measurements on the smoke and gases produced by 141 materials currently used or considered for future use in aircraft interiors.¹ The tests show that a number of materials do not generate large quantities of smoke or gases. The study was sponsored by the National Aviation Facilities Experimental Center, Federal Aviation Agency, the Department of Transportation; the work was carried out by D. Gross, J. J. Loftus, T. G. Lee, and V. E. Gray of the Building Research Division.

The materials studied consisted of fabrics (natural and artificial), sheet and laminate siding materials, rugs, pads, and materials used for ceiling and bulkhead insulation. These materials were supplied by the sponsor.

The tests were conducted in a smoke test chamber recently developed at NBS.² In the experiments a thermal radiation exposure of 2.2 Btu/sec

ft² (2.5 W/cm²) was applied normal to the exterior surface of a nominal 3-by 3-inch specimen. The specimens were subjected to both flaming and nonflaming (smoldering) exposures. To induce open flaming, a small pilot flame was applied at the base of the specimen. These conditions produced a wide range of smoke levels for the different types of materials.

TABLE 1. Description of selected materials

No.	Thick- ness	Color and surface	Designation	Present or in- tended use	Approximate chemical composition (Based on IR spec- troscopy)
103	<i>Inch</i> 1.0	White Porous	Foam	Foam insulation	Chlorinated polyvinyl chloride
104	1.0	White Em- bossed	Assembly	Wall insulation	Glass fabric (100%) bonded to glass- fiber batt
105	.033	Aluminum glossy	Fabric	High-temperature insulation	Aluminum on asbestos
106	.13	Clear glossy	Sheet	Window panes; fabricated parts	Poly (diphenylol propane) carbon- ate
107	.013	White	Fabric	Drapery	Modacrylic (100%)
108	.013	Orange	Fabric	Drapery	Modacrylic (100%)

continued

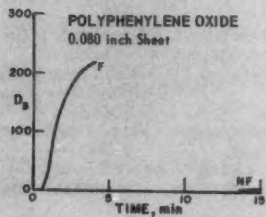
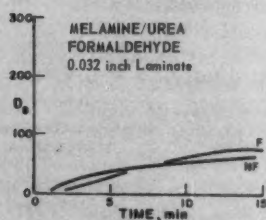
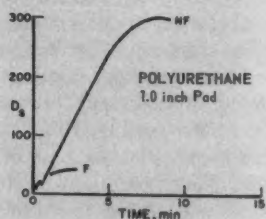
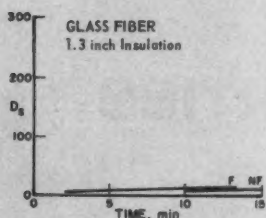
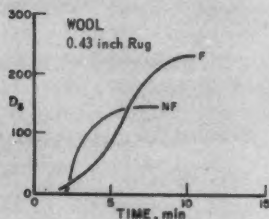
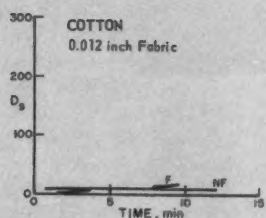


TABLE 2. Summary of results; smoke and gas concentration

Sample number	Specimen weight	Test exposure F=flaming N=non-flaming	Smoke			Gas concentration ^b		
			Maximum optical specific density	Maximum rate	Time to D _s =16 ^a	Maximum indication, colorimetric tube		
						CO	HCl	HCN
	g			min ⁻¹		ppm	ppm	ppm
103	5.7	F	30	6	1.5	330	1600	2
		N	20	2	6.8	110	1300	1
104	9.4	F	25	4	2.8	130	15	5
		N	25	5	3.0	70	12	4
105	5.2	F	11	2	NR	110	35	1
		N	10	1	NR	75	13	0
106	18.4	F	210	70	2.8	400	0	0
		N	12	1	NR	50	0	0
107	1.2	F	39	15	0.4	160	120	35
		N	41	10	0.8	90	100	30
108	1.2	F	39	11	0.6	220	110	30
		N	41	13	0.6	60	100	30

^a Time to reach a "critical" optical density.

^b Within an 18-cubic foot chamber.

Smoke Measurements

Smoke levels were determined by measuring the progressive attenuation of a light beam that was passed through smoke in the closed chamber. Values of smoke level were then obtained in terms of specific optical density.*

Gaseous Products

Indications of the concentrations of gaseous products produced by the specimens were obtained by drawing a sample of the mixture in the smoke test chamber through commercial colorimetric gas-detector tubes. The results were then obtained on the basis of the manufacturers' calibrations for the selected gases. Samples were checked for carbon monoxide, hydrogen cyanide, hydrogen chloride, sulfur

dioxide, nitrogen oxide plus nitrogen dioxide, ammonia, chlorine, and carbonyl chloride. (High concentrations of hydrogen chloride were determined using a specific-ion electrode technique for greater accuracy.) These gases have generally been considered toxicologically hazardous.

In general, it was found that HCl was produced from burning polyvinyl chloride and modacrylic materials; HF, from polyvinyl fluoride; HCN, from wool, urethane, acrylonitrile-butadiene-styrene, and modacrylics; and SO₂ from polysulfone and rubber materials. CO was produced by almost all the samples in varying amounts depending on the type of material.

*The specific optical density (D_s) is a dimensionless attenuation coefficient of a specimen of given thickness; it represents the optical density measured over unit path length (L), within a chamber of unit volume (V), produced from a specimen of unit surface (A). Or,

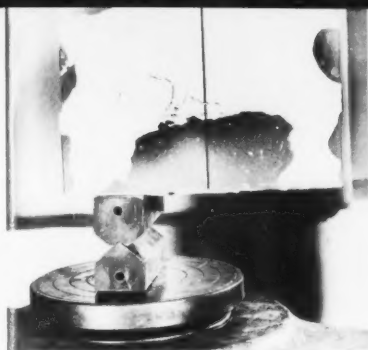
$$D_s = \frac{V}{AL} \log \frac{100}{T}$$

where T is the percent of light transmission.

Typical results of the smoke production characteristics of aircraft interior materials. Specific optical density (D_s) is plotted as a function of time: flammable material—F; nonflammable—NF.

¹ Gross, D., Loftus, J. J., Lee, T. G., and Gray, V. E., Smoke and Gases Produced by Burning Aircraft Interior Materials, NBS Bldg. Sci. Series BSS-18 (to be published).

² Gross, D., Loftus, J. J., and Robertson, A. F., A method for measuring smoke from burning materials, ASTM Spec. Tech. Publication, STP 422, pp. 166-204 (1967).



Eccentricity of Floor Loads APPLIED TO A BEARING WALL

An eccentrically-loaded wall with the loading knife edge applied 2½ inches from the center.

EXTERIOR BEARING WALLS OF BUILDINGS are usually designed as eccentrically (off-center) loaded compression members. It is important, therefore, to know the eccentricities of the forces with which the bearing walls react to the applied floor loads when different bearing-wall materials are used and when different conditions of contact apply between the supporting structure and the floor beams.

A recent study¹ at the Institute for Applied Technology has produced a method for measuring the eccentricity of the reactions of a bearing wall to applied floor loads. The measuring technique was made possible by use of a specially designed stress-sensitive compressive strut, which was calibrated under loads of known eccentricities. The work was carried out by D. Watstein and P. V. Johnson, Research Associates at NBS from the Structural Clay Products Institute.

In the study, parameters affecting the eccentricity of the reaction forces were investigated, such as thickness and rigidity of bearing materials, the intimacy of contact between the supporting structure and the flexural members, and the effect of a bond with the bedding material. The feasibility of measuring the eccentricity of the reaction force at the base of a supporting masonry wall that was subjected to an eccentrically applied load was also explored.

The compressive reaction strut is a rectangular steel tube (4 by 8 in) having a wall 0.187 in thick. The strut is 18 in high and has a ¾-in welded-steel plate insert at the top, which provides a closed end. The strut is capped with a 1- by 4- by 8-in cold-rolled steel plate bonded to the top welded-plate insert with epoxy cement. This assembly is capped with a solid extruded clay brick that serves to receive the load, thus simulating the bearing conditions at the top of a brick masonry wall. The open bottom end of the strut is machined normal to the strut's axis and is supported on a machined steel plate 4 in thick. Strain gages are attached at two levels on the strut's 4-in sides.

The strut was calibrated by applying a load through a hardened-steel knife edge seated in a V-block. The eccentricity of the applied load could be measured with an accuracy of about 1/32 in with a steel scale. The reaction force eccentricities were then obtained in terms of strains on the strut.

Using the calibrated strut, several series of tests were performed to determine eccentricity ratios. (The eccentricity ratio is defined as the ratio of the reaction eccentricity to the overall thickness of the strut.)

For one series of tests, an I-beam was bedded in high-strength gypsum plaster with the I-beam end extending to the center of the strut. In this series both bonded and

TABLE 1. Measured eccentricities of reaction at the base of a wall loaded with a known eccentricity

Wall height	Eccentricity of applied load	Applied load		Measured strains on strut		$\epsilon_{\max} - \epsilon_{\min}$ $\epsilon_{\max} + \epsilon_{\min}$	Measured eccentricity at base of wall
				ϵ_{\max}	ϵ_{\min}		
<i>in</i>	<i>in</i>	<i>pounds</i> $\times 10^3$	<i>newtons</i> $\times 10^4$	10^{-6}	10^{-6}		<i>in</i>
24	0	15	6.6	112	112	0	0.15
24	0	20	8.8	151	149	.007	.16
24	2.5	10	4.4	155	*-10	1.14	2.45
48	0	10	4.4	69	77	-.05	0.06
48	0	20	8.8	148	159	-.04	.06
48	2.5	5	2.2	83	0	1.00	2.20
48	2.5	10	4.4	157	2	0.97	2.14

*Tensile strain.

continued

FLOOR LOADS *continued*

unbonded specimens were tested. For the unbonded plaster bed the eccentricity ratio increased with the applied load to a maximum value of about 0.42, while for the bonded plaster this ratio decreased to an average value of about 0.24 at the maximum load.

In the second series of tests, the eccentricity was observed for an I-beam supported on neoprene rubber pads. Some pads were capped with gypsum plaster putty for tests while others were left uncapped. The rubber sheets were $\frac{1}{16}$ in thick and were stacked to give thicknesses of $\frac{1}{8}$ or $\frac{1}{4}$ in.

In general the eccentricity ratio in this series of tests increased slightly with the applied load. Lack of intimate contact between the I-beam and the rubber pad $\frac{1}{8}$ in thick resulted in an eccentricity ratio of about 0.40, or nearly the same as for unbonded plastic bearing. Intimacy of contact, produced by plaster capping, resulted in a marked reduction in the eccentricity ratio to about 0.29. When the bearing length of the rubber pad was confined to one-half of that used in previous tests and was placed at the extreme end of the beam, the eccentricity ratio was further reduced to about 0.18, and to 0.13 for a rubber pad $\frac{1}{4}$ in thick.

Two exploratory tests were also performed to investigate the feasibility of measuring the eccentricity of the

supporting force at the base of a wall subjected to an eccentrically applied load.

The wall used in these tests was essentially a pier $3\frac{9}{16} \times 7\frac{7}{8}$ inches in cross section, built of solid extruded clay bricks. The bricks were laid in stacked bond with extremely thin joints of high strength plaster. The strut was used as a base for this assembly.

The wall was built in two stages—the first was 24 in high and the second was 48 in high. Two loads were applied at each height, a centrally applied load, and an eccentric load applied on one side 2.5 in from the center line of the pier. Values of eccentricity of applied loads and the measured values of eccentricity of reaction at the base of the wall were obtained.

It was clearly shown that the calibrated strut could be used to measure the eccentricity of the reaction at the base of the bearing wall. In the case of the 24-in wall, for example, noneccentric loads of 15 000 and 20 000 pounds of force yielded eccentricity values of 0.15 and 0.16 in, respectively, at the base of the wall, while 10 000 pounds of force applied $2\frac{1}{2}$ in from the center yielded an eccentricity value of 2.45 in at the base.

¹ For complete details, see Watstein, D., and Johnson, P. V., *Experimental Determination of Eccentricity of Floor Loads Applied to a Bearing Wall*, NBS Bldg. Sci. Series 14 (June 1968). For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 15 cents.

NBS initiates information service on engineering standards

THE NATIONAL BUREAU OF STANDARDS IS NOW prepared to offer information services on published engineering standards and specifications.

The Information Section of the Bureau's Office of Engineering Standards Services has, over the past several years, collected 16 000 engineering and related standards and specifications published by more than 350 U.S. trade, professional, and technical societies. These standards have been cataloged and indexed and are maintained in a technical library. Additionally, a Key-Word-In-Context (KWIC) Index of all of the standards in the collection has been compiled by the Information Section. The Section will function both as a technical library and as a referral activity in providing answers to questions on engineering standards and standards activities, and in directing inquirers to the appropriate standards-issuing organizations for copies of published standards.

The collection of published standards and the compilation of the KWIC Index will enable the Information Section to answer such questions as: Are there any existing standards for a given product? Have test methods been established for determining various characteristics of ma-

terials or products? Has the nomenclature in a particular field been defined? Have specifications for a certain material been established by a nationally recognized organization? Where and how can they be obtained?

For many years NBS has worked closely with national and international organizations that develop and promulgate engineering standards—building and safety codes, purchase specifications, standards of practice, and methods of test. In general, the Bureau's role is to provide the measurement standards and techniques upon which these standards are based. Additionally, the Bureau has through its Office of Engineering Standards Services worked cooperatively with industry groups, under procedures published by the Department of Commerce, in developing voluntary standards for specific products. These standards, previously identified as Commercial Standards and Simplified Practice Recommendations, are now identified as Product Standards and are included in the Information Section's collection of published standards.

Written inquiries concerning published standards should be directed to: Information Section, NBS Office of Engineering Standards Services, Washington, D.C. 20234.



A membrane is carefully positioned and smoothed over the mesh and sealing lip of one side of the cell; the other side will then be clamped against it.

CELLULOSE MEMBRANES, THE ESSENTIAL COMPONENT of artificial kidney and lung machines, selectively pass components of human blood, but do so less effectively than do living membranes. A great deal of research has been expended in search of materials for better and longer-lasting membranes, but this work has been hampered by the lack of a generally accepted means of measuring the properties of interest.

Recently, however, the Bureau has standardized apparatus and methodology for comparing the permeabilities of membranes, in work for the National Institutes of Health (NIH). NBS engineers, Owen Laug and Daniel Stokesberry, developed a measurement procedure that makes diffusive permeability and ultrafiltration measurements more meaningful to biological engineers and experimenters studying membranes. The standard test cell they devised is essential to the success of the method.

Membrane Development Program

One of the programs of the NIH Institute of Arthritis and Metabolic Diseases is to develop new membrane materials having improved transport characteristics and durability. In the absence of a widely accepted single method of measuring the properties to be improved, many researchers devised their own tests. Most of the test results were not comparable and no method stood out as superior to the others. Needed was an inexpensive test cell and simple procedure that would provide unequivocal test results. To fill this need, the National Bureau of Standards was asked to develop a uniform test method for determining membrane characteristics with fluids simulating the body environments for both screening and detailed comparisons of membrane materials.

Test Cell

The test cell devised at NBS consists of two identical plates, each having a 2 x 4-inch shallow channel surrounded by a slightly elevated sealing lip; the membrane sample is clamped for testing between a pair of these plates. Each plate has two short protruding tubes, each leading to a slot machined across the short side of the channel to supply or collect the solution. A piece of polypropylene mesh

Standard Cell FOR EVALUATING ARTIFICIAL MEMBRANES

cut to the same size as the channel, with its strands running at an angle of 45° to the sides, is cemented in place on the surface of the channel. Its surface is nearly flush with the sealing lip.

The cells designed and tested in this work were cast of epoxy resin. If any more cells are needed in the future, a number of them can be produced from the same mold.

The membrane, typically a cellophane-like, clear sheet about 0.001 inch thick, is positioned by being floated above a submerged half cell and deposited as the half is removed from the water. The membrane is held between this half and its mate, aligned by guide pins and clamped together by stainless steel screws and wingnuts around the edge. The membrane seal is tested before use by application of pressure to both channels simultaneously.

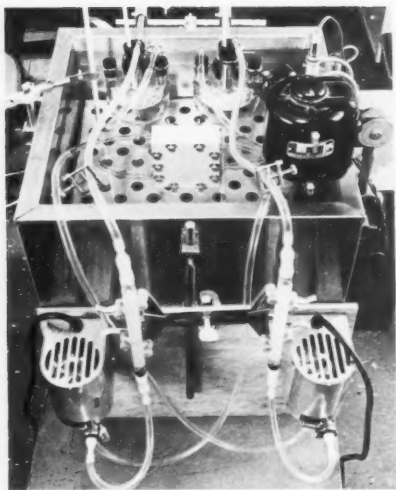
Operation of Test Apparatus

The membrane test cell is used by circulating "blood"—actually a solution of salt, urea, or other substance being investigated—through the cell on one side of the membrane, and the dialysate—initially distilled water—through the other. Turbulence imparted to each solution in passing between the membrane and the polypropylene mesh sweeps away the film of solution clinging to the membrane, preventing boundary layer resistance.

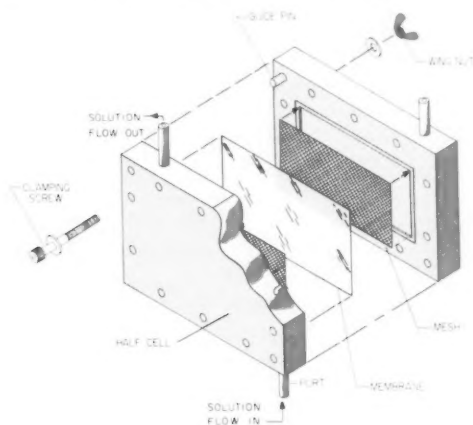
The apparatus is prepared for use by placing a known volume of "blood" and of dialysate in their respective circuits and recording the changing concentrations as a function of time while the solutions are circulated. The fluid flowing through each side of the cell is circulated by a centrifugal pump at a rate monitored by a flowmeter and controlled by constricting the flexible tubing. When the test has proceeded for the desired time the pumps are stopped and the solution in each circuit is drained and weighed to determine the end volume of "blood" and of dialysate.

Most of the fluid in each circuit is contained within a glass reservoir, where the concentration measurement is made, and from which tubing conducts the fluid to its side of the cell. Both reservoirs and the cell are submerged in a circulating water bath that is thermostatted at 37.0 °C (98.6 °F, a normal temperature for the human

continued



Above: Submerged in a water bath are the membrane test cell (center) and two solution reservoirs (top). Pumps (foreground) circulate the solutions through the cell. Below: An exploded view of the membrane test cell shows two similar half cells with a test membrane between. Solutions enter each half cell, eddy across the mesh, and exit through a diagonally opposite port.



body). The temperature within each reservoir is monitored by a mercury thermometer; temperature variations are within 0.1 degree of 37.0 °C, which affects permeability less than 0.5 percent.

Calculations and Findings

Test runs showed that the natural logarithm of the difference in the "blood" and dialysate concentrations when plotted against elapsed time yielded a straight line. This indicates that the diffusion coefficient is independent of concentration over the range of concentrations used in these measurements.

The permeability of the membrane was determined in two ways. The more basic method is by calculation from

a formula using the beginning and end-point concentrations, the end-point volumes, the membrane area (0.00516 m² for this test cell), and the duration. The other, equivalent calculation, uses the end-volumes, the membrane area, and the slope of the time-concentration difference logarithm curve.

It was found in general that widely varied concentrations of solute did not greatly affect the permeability of the membranes tested, although this might not hold for solutes not tested. The measured value of permeability was found to be reasonably constant over a fairly broad range of fluid flow rates. Thus, if the measurement is made in this region, small variations in flow rate will not adversely affect the reproducibility of the measurement. High flow rates permanently increased permeability, perhaps by stretching the membrane, so that it is important not to exceed the specified flow rate. Low flow rates, on the other hand, do not provide enough turbulence to reduce the fluid-skin resistance. A flow rate of 0.6 liter per minute was specified for the tests.

Some precautions should be observed in using this test procedure. The test must be run long enough to create a significant concentration change for acceptable certainty and to minimize the difficulty of measuring small change. The more dilute the solution, the longer the test run required to yield a desired concentration change.

Statistical analysis showed that variation in permeability determinations for a single sample is less than sample-to-sample variations. This indicates that measurements with the cell have excellent reproducibility.

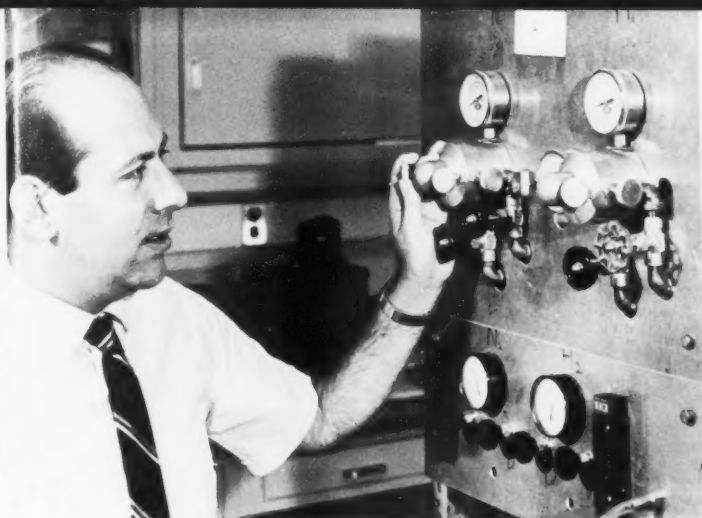
Ultrafiltration Tests

A modified test setup including the test cell can be used in determining the ultrafiltration characteristics of membranes. With the application of a transmembrane pressure, solvent is transferred across the membrane. This technique is of great interest in designing equipment to remove excess water from the bloodstreams of victims of kidney failure.

The amount of solvent passing through the membrane when a pressure is applied is indicated by changes of the level in pipettes connected to each side of the test cell. Ultrafiltration pressure coefficients (in ml/hr-cm²-mm Hg) obtained for transmembrane pressures from 100 to 500 mm Hg were constant, indicating that the membrane had not stretched. A standard pressure of 200 mm Hg was selected; greater pressures should be avoided to ensure against permanent stretching of the membrane.

Other Dialysis Research

Membrane permeability is only one of several problem areas that could not be approached until standard permeability measurements were established and in use. Areas that now can receive attention from other scientists are the development of a blood substitute and of a reference membrane.



S. Abramowitz adjusts coolant flow before making a far infrared spectroscopic measurement of matrix-isolated lithium fluoride.

Data Obtained on LITHIUM FLUORIDE STRUCTURE

PREVIOUS STUDIES ON LITHIUM FLUORIDE have resulted in some controversy regarding the structure of its various high-temperature species. As knowledge of the structure of these compounds is important for understanding chemical reactions, for high-temperature technology, for determining material properties, and for indicating potential applications, further information on the gaseous species of this compound has been needed.

In an attempt to resolve differing interpretations of the infrared spectrum of matrix-isolated lithium fluoride, S. Abramowitz and N. Acquista of the NBS Institute for Basic Standards and I. W. Levin of the NIH National Institute of Arthritis and Metabolic Diseases, recently extended the measurements on this system into the far infrared region.¹ Data were obtained from ^6LiF and ^7LiF isotopic species, as well as from mixtures of these isotopic compositions. By then subjecting the data to a normal coordinate analysis, evidence was obtained supporting a linear dimer Li_2F_2 structure in addition to other known species.

In the NBS study, ^6LiF , ^7LiF , and various mixtures were vaporized from double boiler Knudsen cells with an electron bombardment furnace. The vapor was then deposited in an argon matrix on thin cesium iodide windows at liquid hydrogen temperatures. The ratio of argon to lithium fluoride (500:1 to 1000:1) was sufficiently large to isolate the various species of lithium fluoride.

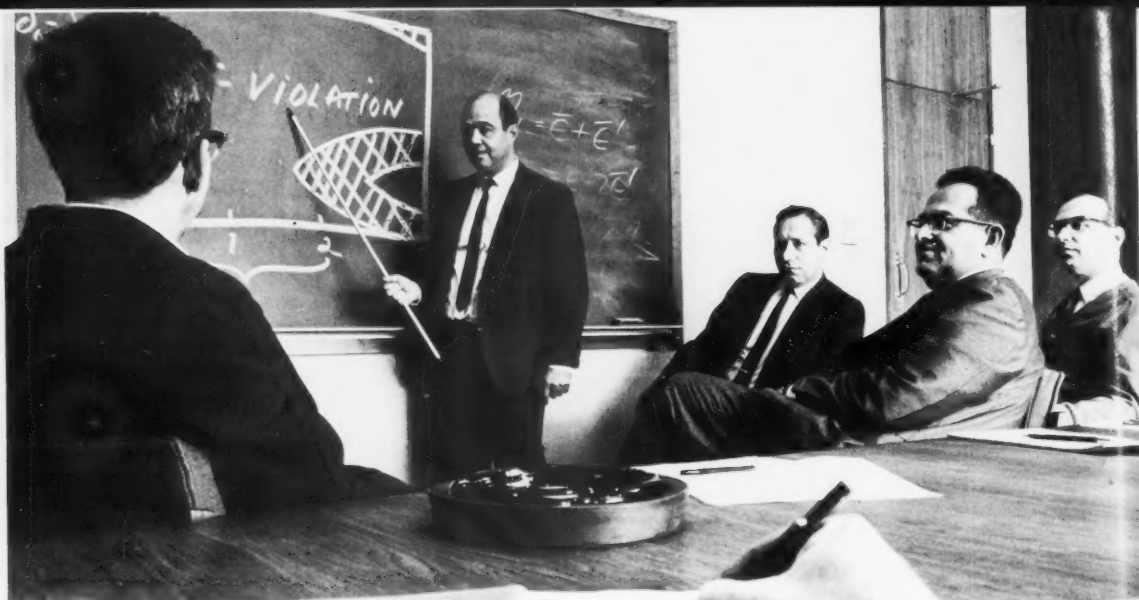
Infrared spectra of matrix-isolated ^6LiF , ^7LiF , and mixtures of the isotopes were obtained in the region from

1000 to 150 cm^{-1} . In addition to features ascribable to the monomer and ring-shaped dimer, other features appeared. The use of warm-up experiments and deposition from higher effusing temperatures facilitated assignment of the observed features.

The assignment of five frequencies to a linear Li_2F_2 dimeric species was supported by a normal coordinate analysis for the isotopic systems. Several models for the linear structure were considered; namely, a F-Li-F-Li dimer in which all bonds were equivalent, a $\text{F-Li-F} \cdots \text{Li}$ dimer with a bifluoride structure, and a $\text{F-Li} \cdots \text{F-Li}$ species containing an elongated central bond.

For the normal LiF bonds of the model structures, a bond length of 1.51 \AA was assumed, while a value of 2.01 \AA bond length from crystalline LiF x-ray diffraction measurement was taken for the long bonds. The intermolecular force field for a chosen model was first refined about the $^6\text{Li}_2\text{F}_2$ and $^7\text{Li}_2\text{F}_2$ isotopic species by systematically varying interaction force constants until close fits to the observed frequencies were attained. This force field was then used to calculate the frequencies for the mixed isotopic species, namely, the $\text{F-}^6\text{Li-F-}^7\text{Li}$ and $\text{F-}^7\text{Li-F-}^6\text{Li}$ molecules. The close frequency fit obtained between the experimental and calculated values for the mixed isotopic molecules coupled with other experimental results was taken as evidence of a linear dimeric structure.

¹ Abramowitz, S., Acquista, N., and Levin, I. W., *Infrared matrix spectra of lithium fluoride*, J. Res. NBS **72A** (Phys. and Chem.), No. 5, 487-493 (Sept.-Oct. 1968).



Time Reversal Symmetry Violated

A RECENT STUDY AT THE NATIONAL BUREAU OF STANDARDS has shown that time reversal symmetry, a principle of physical theory first questioned some four years ago, does not remain valid under all conditions, as evidenced by the "slow" nuclear K^0 meson decays. This demonstration, by Russell C. Casella, a theoretical physicist, appears to settle the fundamental question of the reversibility of the time coordinate in the "weak interactions" of nuclear physics.¹

Time reversal symmetry is closely related to parity conservation, a concept that in 1957 was shown not to hold in the beta decay of cobalt-60 nuclei. Parity conservation in nuclear physics implies a type of space symmetry that makes no distinction between right- and left-handed rotations of electrons, mesons, and other elementary particles. Time reversal symmetry is an analogous concept regarding time in physical processes. Thus, if time reversal symmetry is truly valid in elementary processes, then changing the algebraic sign of the time variable in time-space equations should make no difference in the nature of these processes. For instance, from time reversal symmetry, the important principle of detailed balance in gaseous molecular collisions follows.

Parity conservation, time reversal symmetry, and invariance under charge conjugation are three concepts that have been the subject of much investigation by physicists in recent years. Charge conjugation, for example, relates an entity with charge e^+ , the electric charge of the proton, to a similar but reverse charge e^- , the charge of the antiproton.

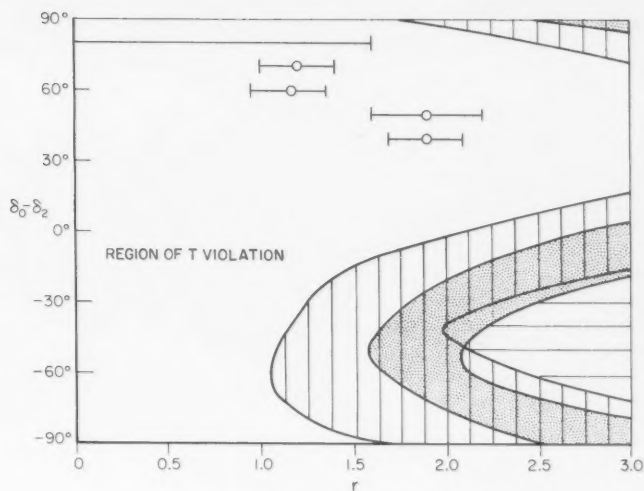
Taken together, time reversal (T), charge conjugation (C), and parity (P) are assumed to constitute a fundamental symmetry of nature, expressed as the "CPT theorem." Briefly, this theorem states that the laws of nature remain invariant under the sequentially combined operations C, P, and T, whether or not each of the constituents, or any twofold combination of them is in itself a valid symmetry.

The past eleven years have brought about drastic changes in the acceptance of the separate concepts comprising the CPT theorem. Prior to 1957 not only the CPT theorem but also its components C, P, and T were accepted as valid symmetries for all matter. However, at that time, NBS scientists E. Ambler, R. W. Hayward, D. D. Hoppes, and R. P. Hudson, together with C. S. Wu of Columbia University, produced the first evidence that the parity symmetry is broken by an appreciable amount for beta decay.²

Soon afterwards Professors T. D. Lee and C. N. Yang, who first suggested ways of observing the parity violation,³ as well as the Russian physicist L. D. Landau, pointed to the possibility that a compensating violation in symmetry for charge conjugation might also exist for the same experiments. If so, then the combinations CP, T, and CPT could remain valid symmetries in nature.

In 1964, however, scientists at Princeton University⁴ found that the combination CP is not conserved in the decay of the K^0 meson (kaon) into two other mesons (pions). Because this symmetry is broken, then if one assumes that the total operation—CPT—is valid, T must

Left: Russell Casella answers a question put to him by Joseph Coyne (left) as (left to right) Hans Frederikse, Sydney Meshkov, and Albert Feldman look on. Right: Graphic mapping of the region of T violation. The abscissa, r , is the ratio: kaon decay amplitude into two neutral pions over kaon decay amplitude into two charged pions. Data points with appropriate error bars relate only to the abscissa. The ordinate, $\delta_0 - \delta_2$, represents phase shift difference due to mutual interaction of kaon-produced pions. Recently, an ambiguity in this quantity was eliminated, with the result that $\delta_0 - \delta_2$ almost certainly lies between $+10^\circ$ and $+80^\circ$. By examining the plot, T is shown to be violated. The shaded region shows where, before eliminating the ambiguity, the remote but exciting possibility of a T-conserving, CPT-violating interaction existed. Lined regions are those now under study whose outer limits are in the process of being removed, leaving a larger region of T violation.



be violated by an equal but opposite amount to counteract the CP violation. Considerable interest⁵ has arisen as to the validity of T invariance, irrespective of CPT invariance. Seeking an answer to this, Dr. Casella began an analysis of the experimental data on K^0 meson decays.

There is strong theoretical bias for believing in the CPT theorem because the theorem follows directly from other more basic principles: special relativity, quantum mechanics, and microcausality (as expressed in the language of local field theory). Were the theorem to fail, the universal validity of one of these pillars of physics would have to be abandoned.

If one accepts CPT as an exact symmetry of nature, then, as noted earlier, the 1964 discovery of CP violation implies a compensating violation of T. However, the ultimate test of any theory, including CPT, lies with experiment. Thus far, CPT symmetry has held true when confronted with experiment, most recently in connection with the predicted equality of the oppositely charged pion lifetimes.⁶ Nevertheless, it remains to be verified (or rejected) at the level of accuracy inherent in the delicate K^0 interference experiments.

That the issue can be decided by these experiments follows from an analysis of these effects by T. T. Wu and C. N. Yang, who assumed little more than CPT invariance.⁷ However, it has not yet been possible to accomplish this feat because of the extreme difficulty of the experiments, particularly in the decay, without CP symmetry, of the neutral (uncharged) kaon into two neutral pions, none of which leaves ionized tracks.⁸

Thus, although theorists expect the CPT question eventually to be resolved in favor of the theorem, it is very useful to decide now for or against the principle of time reversal invariance with currently available data. This is especially so because in all previous cases where it has been possible to test this principle directly by experiment, it has been found valid.⁵ Dr. Casella chose to analyze the slow decays of the neutral kaon into two pions because here, as mentioned earlier, one suspects that T is broken. He has established T violation directly by initially assuming the opposite, namely, T invariance of the basic interaction responsible for the decays. This assumption led to gross internal inconsistencies among the data over wide ranges of the parameter values embracing the most probable experimental values.¹ His result is consistent with, but independent of, the CPT theorem, and represents the first direct indication of T violation.

¹ Casella, R. C., Time reversal and the K^0 meson decays, *Phys. Rev. Letters* **21**, No. 15, 1128 (1968).

² Reversal of parity law in nuclear physics, *NBS Tech. News Bull.* **41**, No. 4, 56 (1957).

³ Lee, T. D., and Yang, C. N., *Phys. Rev.* **104**, No. 1, 254 (1956).

⁴ Christenson, J. H., Cronin, J. W., Fitch, V. L., and Turlay, R., Evidence for the 2π decay of the K^0_s meson, *Phys. Rev. Letters* **13**, No. 4, 138 (1964).

⁵ Okun, L. B., *Comments on Nuclear and Particle Physics* **2**, No. 4, 116 (1968).

⁶ Ayres, D. S., Cormack, A. M., Greenberg, A. J., Kenney, R. W., Caldwell, D. O., Elings, V. B., Hesse, W. P., and Morrison, R. J., *Phys. Rev. Letters* **21**, No. 4, 261 (1968).

⁷ Wu, T. T., and Yang, C. N., *Phys. Rev. Letters* **13**, No. 12, 380 (1964).

⁸ Fitch, V. L., *Comments on Nuclear and Particle Physics* **2**, No. 3, 63 (1968).

New Laser Technique Gives Precise Length Measurement

NATIONAL BUREAU OF STANDARDS SCIENTISTS in Boulder, Colo. have developed a potential length reference that promises to be nearly one thousand times as reproducible as the krypton-86 wavelength adopted as an international standard in 1960.¹ This development results from a new stabilized laser technique which was revealed in a paper by Richard L. Barger, of the NBS Radio Standards Physics Division, and John L. Hall, Laboratory Astrophysics Division, NBS Institute for Basic Standards, published in a recent issue (Jan. 6, 1969) of *Physical Review Letters*.² The technique is based on the saturated absorption in methane vapor of radiation from a 3.39-micrometer helium-neon laser. Several devices using this principle have been constructed by Drs. Barger and Hall.

Reproducibility and stability are the critical factors in measuring lengths with light waves. The orange-red radiation from a krypton-86 lamp replaced the meter bar as the international standard of length because the light is very stable and accurately reproducible. However it is not a perfect standard because it cannot be used directly to measure long distances. Since its invention in 1960, the laser has been investigated in regard to its possible use as a standard of length because of its coherence, i.e., the output radiation is composed of waves uniform in length and all travelling the same direction. However, research has shown that the operating conditions of the laser discharge cell affect the output wavelength to a degree unacceptable for standards work. Now the two NBS scientists have developed a device which stabilizes the laser output wave-

length to a molecular absorption line in a passive cell of methane gas. Approximately the same concept forms the basis of the modern and extremely accurate atomic standards of frequency and time.

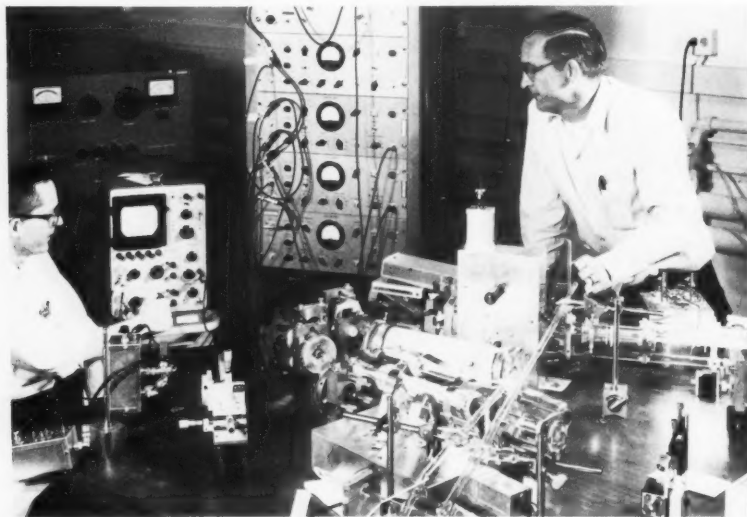
Using saturated absorption to obtain a sharp resonance, the two scientists have achieved a basic-line width for the signal of about one part in a billion, and they have demonstrated a reproducibility of one part in one hundred billion for two independent devices. Pressure shift measurements, using sophisticated frequency-offset locking techniques introduced by Dr. Hall, have shown that the shift is very small, so that the resulting stability could be comparable to the reproducibility.

In these saturated-absorption, methane-stabilized lasers the output wavelength is in the infrared, but a visible helium-neon laser can be locked to it with extremely high stability and with built-in provisions for precisely measuring the wavelength of the visible output radiation by interferometric methods.

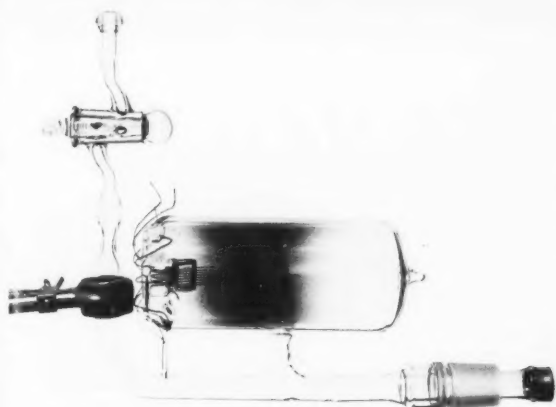
In addition to possible consideration as a new international standard of length, the saturated absorption-type laser will have important applications as an accurate length reference for geophysical measurements and in high-accuracy measurements of the speed of light.

¹ Wavelength of Kr^{86} light becomes new international standard of length, NBS Tech. News Bull. 44, No. 12, 199 (Dec. 1960).

² For further details, see Barger, R. L., and Hall, J. L., Pressure shift and broadening of methane line at 3.39 microns studied by laser-saturated molecular absorption, Phys. Rev. Letters 22, No. 1 (Jan. 1969).



John L. Hall (left) and Richard L. Barger view the laser's saturated absorption resonance line in methane vapor on the oscilloscope screen while Dr. Barger adjusts the laser mirror.



The rare-gas resonance lamp consists of a glass discharge tube (bottom), a ballast (center), a stopcock (left) through which the rare gas enters, and a window (right).

Rare-Gas Lamp

Provides High Energy Radiation

SCIENTISTS AT THE BUREAU have devised a rare-gas resonance lamp that serves as an intense, stable source of far-ultraviolet radiation. Using the NBS design, microwave-operated, enclosed lamps that emit helium and neon resonance radiation have recently been prepared for the first time. The resonance lamps, which are used for photochemical studies, were designed by the staff of the Radiation Chemistry Section, Institute for Materials Research.¹

Such lamps have been used as long as several months without deterioration, providing radiation that is free from spectral impurity and has a steady intensity. The new design thus solves the problems encountered with rare-gas resonance lamps of other designs, which often deteriorate after only a few hours.

Basically, the lamp consists of a glass tube containing the noble gas, a ballast volume perpendicularly attached to the tube, and a window for transmitting the radiation. A microwave source surrounds the tube to produce the excitation of the gas atoms.

The ballast is a one-half liter volume containing the major quantity of the rare gas. Within the ballast are titanium "getter" wires with leads extending through one end of the tube. The titanium absorbs all impurity materials, thus preventing the production of unwanted

impurity radiation. This greatly improves the spectral purity and stability of the beam.

To transmit the radiation of xenon, krypton, and argon, thin windows made of lithium fluoride may be used. In the case of the new helium and neon lamps, a very thin film of aluminum, attached to a backing material, was necessary to transmit the 21.2 or 16.7 electron-volt photons produced. Lack of suitable windows that transmit in this wavelength range has, until now, prevented the fabrication of enclosed neon or helium lamps. Fabrication of the very thin aluminum windows was made possible by use of a technique developed by NBS scientists at Boulder, Colo.²

Before the lamp is filled, it is evacuated for several hours on a high vacuum line and heated to around 520 K to drive off adsorbed water. A current is then passed through the titanium wires, causing the titanium to deposit on the walls of the ballast. This "getter" surface absorbs small amounts of impurities that may be present in the noble gas or knocked out of the glass walls during operation of the lamp. Next, the noble gas is introduced and the lamp is sealed off or closed with a stopcock. In case a leak develops, the lamp can be attached again to the vacuum line and a new layer of titanium deposited before refilling.

Use of the Lamp

In the NBS laboratories, the lamps are fitted with standard taper joints so that they can be inserted directly into reaction vessels, where the sample gas that is to be irradiated is placed. Absorption of radiation from the lamp then causes excitation and/or ionization of molecules in the sample. For a sample gas that undergoes ionization during photolysis, the reaction vessel is fitted with parallel plate electrodes so the current generated in the sample during irradiation can be measured, thus providing a direct measurement of the number of ions formed.

The ionization efficiency (ions formed per photon absorbed) of a given compound can be determined by comparing the current obtained in the compound with the current obtained in a gas of known ionization efficiency under identical conditions of lamp intensity. Thus, current measurement provides a simple and reliable means of actinometry for photolysis with ionizing photons.

Studies carried out at NBS have utilized the high-energy resonance lamp to form ions in investigations of the chemical reactions of ions with neutral molecules. In addition, the lamp has been used to study the unimolecular decomposition of neutral molecules excited to energies greater than the ionization energies. The intensity of the lamp is sufficiently great that analyzable quantities of chemical products resulting from such processes are formed.

¹ Ausloos, P., and Lias, S. G., Gas-phase photolysis of hydrocarbons in the photoionization region, *Rad. Res. Rev.* **1**, 75-107 (1968).

² Improved process gives high-quality thin aluminum films, *NBS Tech. News Bull.* **51**, No. 12, 262 (Dec. 1967).

TRANSDUCER EVALUATION

MORE ECONOMICAL AND MEANINGFUL MEASUREMENTS

IMPROVED APPARATUS AND PROCEDURES for evaluating transducers have resulted from a long-term program that the Institute for Applied Technology has been conducting for agencies that use transducers. The knowledge and techniques gained in this program are of significance to users in both government and industry.

Transducers are essential for missile, rocket, and aircraft flight instrumentation. They are also being used increasingly by nonaerospace industries in systems for the indication and control of pressure, temperature, position, displacement, and acceleration. Often, however, transducers are the weakest link in a system because of limitations in their performance.

To provide data on the factors affecting transducer performance and to develop methods and equipment for testing these devices, a number of Government agencies established an InterAgency Transducer Project at NBS in 1951.¹ Now supported by the Naval Air Systems Command and the NASA Office of Advanced Research and Technology, the Project is being conducted under the direction of Paul S. Lederer.

Project Objectives

The InterAgency Transducer Project renders several types of services: (1) It investigates methods for the precise measurement of changing physical quantities, frequently entailing development of new techniques and apparatus; (2) it evaluates the effects on transducers of environments in which they are used or stored; (3) it studies the durability of transducers in order to develop

equipment and procedures for life testing; (4) it investigates principles and materials for use in improved techniques and apparatus; (5) it participates in the development of standards and recommended practices through NBS membership in professional societies and user organizations; and (6) it evaluates the performance characteristics of transducers employing novel operating principles or newly developed materials.

One of the most effective methods of supplying information to transducer users and appraising their needs has been NBS participation in the Telemetry Working Group of the Inter-Range Instrumentation Group. Through this organization NBS reaches a broad range of transducer users in military agencies, civilian agencies, the aerospace industry, educational institutions, and research institutions. The Bureau has been host to two Transducer Workshops organized by the IRIG Transducer Committee² and has contributed greatly to the technical content of these sessions by reports of NBS transducer research and practices.

Transducer Services Offered

NBS has developed a number of techniques and devices it uses in calibrating and evaluating transducers in the InterAgency Transducer Project; they are described briefly below.

The *earth's field static calibrator for accelerometers* is an inexpensive but highly accurate device for statically calibrating accelerometers between the values of $+1$ and -1 g, with estimated errors within ± 0.004 g.³ Sim-

ply constructed in any laboratory, it has the advantage of being self-calibrating.

An *earth's field dynamic calibrator* also has been developed for calibrating accelerometers between $+1$ g and -1 g from 0.5 Hz to about 30 Hz.⁴ Electrical connections are brought out by means of sliprings. This device is best suited for use with accelerometers having negligible response to transverse excitation.

A *dual centrifuge* developed at the Bureau produces accelerations in the frequency range of 0.5 Hz to about 30 Hz with amplitudes up to ± 100 g between 10 Hz and 30 Hz.⁵ Its linkage and belts are arranged so that the instrument turntable has zero angular velocity at all times and the instrument tested is subjected to sinusoidal linear motion along its sensitive axis. Because this device also subjects accelerometers to transverse accelerations, its use is limited to those sensors relatively insensitive to such acceleration.

The dynamic response of a pressure transducer is generally determined from its transient response. Pressure steps of rise time of less than 10^{-8} second are obtained for this purpose at the Bureau in a 20-foot *shock tube*.^{6,7} Steps over the range of 6 to 1000 psi and of about 4.5 ms duration are obtained by rupturing a membrane separating differentially pressurized portions of the tube. The amplitude of the pressure step is computed from the test parameters.

The *pneumatic step function calibrator* performs a similar function by applying a pressure step, accurately known from static measurements,

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from 2 to 100 psi.⁸ The rise time is about 0.9 ms—longer than that of the shock tube—and the step has superimposed on it oscillations which are damped to less than 2 percent of the step amplitude within 15 ms. This device is especially useful for inspecting transducers for dynamic errors at low frequencies, such as those caused by hysteresis.

A similar purpose is served in a different medium by the *liquid medium step function calibrator*, which supplies a step function having a rise time of less than 3 ms.⁹ Oil is used as the medium at pressures from 500 to 3000 psi, measured statically with a precision of ± 0.2 percent. This device, like its pneumatic equivalent, is useful for inspecting transducers for dynamic errors at low frequencies.

Far from being linear instruments sensitive along only one axis, most pressure transducers are multiple-degree-of-freedom systems and may be nonlinear in response. Such systems are analyzed at the Bureau by magnetically recording the response on a special *transient recorder* which repeatedly plays the response back into an *electronic frequency analyzer*.⁶ The recording system has a flat response from 1.5 to 80 kHz and can record transients of as little as 1 ms duration and 1 mV amplitude. The analyzer can identify equiamplitude signals that are less than 1 kHz apart and frequencies an octave apart and differing in amplitude by ratios of 100:1.

Thermal gradient effects in flush-mounted pressure transducers are assessed by a device which plunges the sensing element into a pool of molten Wood's metal.¹⁰ The effect on the zero

indication, especially, of transducers subjected to thermal variations is evaluated by this means.

The effect of the repeated application of pressure stimuli on the performance characteristics of pressure transducers is determined by *life testing* the pressure transducer on a cycling apparatus.¹¹ A motor-driven cam applies and relieves the test pressure 3000 times an hour. The test is interrupted at prescribed intervals and the transducer's static performance characteristics determined for comparison with the initial condition. Transducers are tested on this apparatus for a million cycles in order to assess possible deterioration in performance.

¹ Lederer, P. S., NBS InterAgency Transducer Project, NBS Tech. Note 469 (Oct. 1968), available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 30 cents.

² Fifth transducer workshop meets at NBS, NBS Tech. News Bull. 51, 266-267 (Dec. 1967).

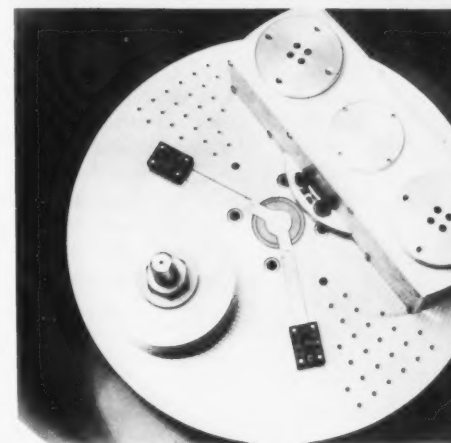
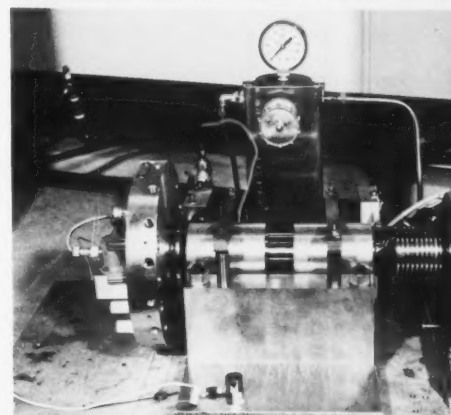
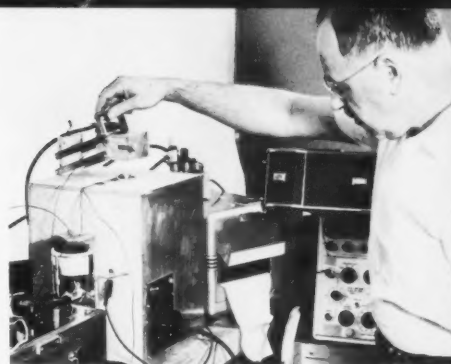
³ Easily made device calibrates accelerometer: Earth's field used as a standard, NBS Tech. News Bull. 50, 94-96 (June 1966); and Lederer, P. S., and Hiltner, J. S., *Earth's Field Static Calibrator for Accelerometers*, NBS Tech. Note 269 (Feb. 1966), available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 20 cents.

⁴ Wildhack, W. A., and Smith, R. O., *A basic method of determining the dynamic characteristics of accelerometers by rotation*, Instr. Soc. Am. Paper 54-40-3 (Sept. 1954).

⁵ Smith, R. O., Willis, E. A., and Hiltner, J. S., *A dual centrifuge for generating low-frequency sinusoidal accelerations*, J. Res. NBS 66C (Engr. and Instr.), No. 4, 357-362 (Oct.-Dec. 1962).

⁶ Pressure transducer evaluation studied, NBS Tech. News Bull. 52, 150-152 (July 1968); Lederer, P. S., *Methods for Performance-Testing of Electromechanical Pressure Transducers*, NBS Tech. Note 411 (Feb. 1967), available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 25 cents.

⁷ Schweppe, J. L., et al., *Methods for the Dynamic Calibration of Pressure Transducers*, NBS Mono. 67 (Dec. 1963), available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 60 cents.



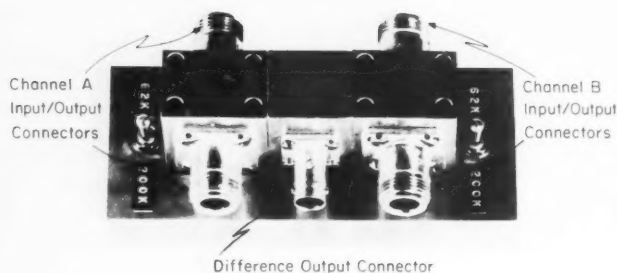
⁸ Lederer, P. S., U.S. Patent 3,034,332, *Step Function Pressure Calibrator* (May 1962).

⁹ Smith, R. O., *A liquid medium step-function pressure calibrator*, ASME J. Basic Eng. Trans. 86, 723-728 (Dec. 1964).

¹⁰ Pressure transducer response affected by thermal gradients, NBS Tech. News Bull. 50, 64-65 (Apr. 1966); Horn, L., *The response of flush diaphragm pressure transducers to thermal gradients*, Instr. Soc. Am. Paper 13.3-3-65 (Oct. 1965).

¹¹ Lederer, P. S., *Life Cycling Test on Several Strain Gage Pressure Transducers*, NBS Tech. Note 434 (Oct. 1967), available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 20 cents.

Wideband RF Voltmeter-Comparator

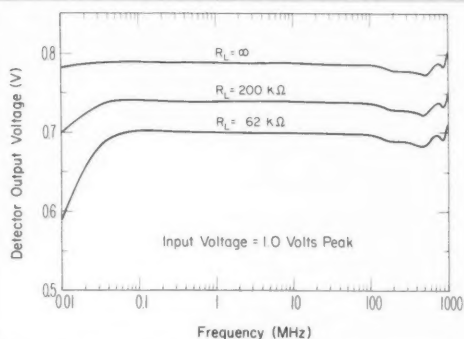
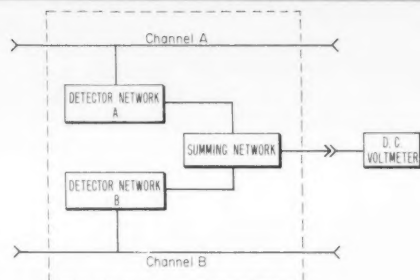


THE AEROSPACE, ELECTRONIC EQUIPMENT-MANUFACTURING, and communications industries are particularly concerned with accurate measurements of rf voltage in their research, quality control, and standards laboratories. They require these measurements at frequencies up to 1 GHz or more, and frequently they require that such measurements be made in coaxial systems. Further, they require that the measurements cause minimum disturbance to the impedance of a system being tested. While rf voltmeters have been available to make these measurements, the short-term stability and the resolution of these devices are not adequate for the more demanding and precise types of such measurements.

A voltmeter-comparator to make these demanding and precise measurements has been developed by L. D. Driver and M. G. Arthur¹ of the NBS Radio Standards Engineering Division at Boulder, Colo. In the course of research on radio noise standards, they developed the device to allow for adjusting two rf voltages to the same level within 0.5 percent and for monitoring the relative change in the voltages over a time period of hours. The voltage range extends from 1 to 15 volts (peak), while the frequency response is essentially flat from 10 kHz to 1 GHz.

This voltmeter-comparator is a completely passive dual-channel, coaxial 50-ohm feedthrough device that uses matched diodes as detectors of peak voltage amplitudes. Diode loading is such that negligible power is extracted from the signal.

Because of circuit configuration, the device is basically a differential voltmeter and as such it has its greatest usefulness. This dual-channel design also greatly reduces ambient temperature variation effects and allows greater resolution (at least 1 part in 10^5) than do other types



Left: NBS-designed, small-size voltmeter/comparator shows the two input channels and the difference output connector. Right, top: Diagram of the wideband rf voltmeter-comparator. Right, bottom: Detector output voltage plotted as a function of frequency and load resistor illustrate the flat output over a wide range of frequency.

of rf voltmeters. Absolute values of rf voltage may be measured, however, by using a reference dc voltage in one channel. The limit of uncertainty, in this case, is less than 1 percent to 100 MHz and less than 3 percent to 1 GHz.

Operation

The use of diodes as rectifiers in rf voltmeter design is a well known practice. Normally the diodes in such instruments respond to the peak value of the input waveform and the rectified output is processed and displayed on a meter scale calibrated in rms volts. Many of these voltmeters exhibit poor stability due to the inherently high temperature coefficients of rectifying diodes, and can offer only a low degree of resolution because of limitations in readability of the type of display used.

The new NBS voltmeter-comparator also makes use of rectifying diodes. In this device, however, thermal stability is greatly enhanced by using two separate detector circuits, arranged in such a manner that the temperature coefficients of the individual diodes tend to compensate one another. Also, because the device is completely passive, the internal circuitry is not as prone to drift as are active circuits such as amplifiers used in some types of voltmeters. Very high resolution (at least 1 part in 10^5) is

obtained by essentially bucking the outputs of the two detector networks against each other and displaying their difference on a sensitive dc voltmeter or potentiometer.

Construction Features

The diodes used in this wideband rf voltmeter-comparator are hot-carrier type diodes that are characterized by (1) high forward conductance, (2) low reverse leakage, (3) low turn-on threshold, and (4) very fast response to changes in junction bias. These characteristics allow high and very nearly constant rectification efficiencies up through the UHF range.

The temperature dependence of the forward conductance of the diodes essentially determines the stability of the voltmeter-comparator. Semiconductor diodes characteristically exhibit rather large temperature coefficients; the diodes used in this case have coefficients of approximately $-1500 \mu\text{V}/^\circ\text{C}$. In the differential configuration, however, the temperature coefficients of the diodes tend to compensate one another. Near room temperatures the composite temperature coefficient is less than $100 \mu\text{V}/^\circ\text{C}$. The diodes were selected on the basis of very similar forward V-I characteristics.

The voltmeter-comparator housing has two short coaxial transmission lines built into it. These lines are fitted with coaxial connectors and comprise the bi-directional input-output channels. This through-type configuration allows insertion of the device into a 50-ohm system with minimum disturbance to existing impedances.

The detector networks are built in modular form and are housed in threaded holes in the underside of the aluminum housing.

For those applications requiring maximum stability, a temperature controlling plate is attached to the bottom side of the voltmeter-comparator. Water from a temperature regulated bath can be circulated through this plate.

Other Applications

In addition to applications as a voltmeter or as a monitor, the voltmeter-comparator is suited to many other uses. It can be used to indicate when the magnitudes of two voltages are equal. Applications of this sort include balancing active and passive push-pull networks, center-tapping transformers, and adjusting attenuator networks to have equal attenuation.

Because of its wide bandwidth and very flat frequency response, the voltmeter-comparator is an excellent choice for certain swept frequency measurements, such as that of a sensitive detector for level controlling the output voltage of a swept frequency oscillator.

Other applications are possible in the areas of voltage calibration, systems development and evaluation, and servicing precision laboratory equipment. Because of these and still other applications, a set of engineering drawings for the voltmeter-comparator is available upon request from L. D. Driver or M. G. Arthur at NBS, Boulder, Colo.

¹ Driver, L. D., and Arthur, M. G., A wide-band rf voltmeter/comparator, IEEE Trans. Instr. Meas. 17, No. 2, 146-150 (June 1968).



STANDARDS AND CALIBRATION

STANDARD FREQUENCY AND TIME BROADCASTS

WWV—2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz

WWVH—2.5, 5.0, 10.0, and 15.0 MHz

WWVB—60 kHz

Radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast signals that are kept in close agreement with the UT2 scale by making step adjustments of 100 ms as necessary. Each pulse indicates that the earth has rotated approximately 15 arcseconds about its axis since the previous one. The pulses occur at intervals that are longer than one second by 300 parts in 10^{10} due to an

offset in carrier frequency coordinated by the Bureau International de l'Heure (BIH), Paris, France. Adjustments are made at 0000 UT on the first day of a month. *There will be no adjustment made on April 1, 1969.*

Radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses derived from the NBS Time Standard (NBS-III) with no offset. Step adjustments of 200 ms are made at 0000 UT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be an adjustment made on April 1, 1969. The seconds pulses emitted from WWVB will be retarded 200 ms.*



NEWS

This column regularly reports significant developments in the program of the National Standard Reference Data System, which was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The System is administered and coordinated by the NBS Office of Standard Reference Data.

Evaluation of Rate Data

The remarks below were excerpted from a talk by David Garvin, Director of the NBS Chemical Kinetics Information Center, at the Specialists' Session on Chemical Kinetics Calculations, which was held October 30, 1968, at the University of California, Berkeley. The program was sponsored by the Western States Section of the Combustion Institute. Although Dr. Garvin's talk was on the evaluation of chemical kinetic data, some of his remarks are applicable to data evaluation in general.

What is data evaluation? The concept is ill defined. A definition that fits the practice in kinetics is that an evaluation is the opinion of a person who has examined the available evidence and has presented a recommended value. If there are no data available, the evaluator may produce a best estimate using his intuition and whatever rules he favors. Consistency is a virtue at this level of evaluation. If data are available, he may select the results of one study as being the most reliable. Also, he may merge part or all of the available data either according to a fixed rule, such as a least-squares fit, or make a subjective judgment to establish the most reasonable trend suggested by the data. In any case, the result is his opinion. To be accepted it must survive the scrutiny of his colleagues and must be presented in an easily used form.

There is no single source to which a user may refer for rate compilations and evaluation. The tempo of evaluated rate data work has increased in recent years, but the results are widely scattered and often are difficult to identify.

The field of "light-molecule reactions" has received the most emphasis in recent years. (These are the reactions of atoms, diatomic and triatomic molecules of carbon, oxygen, nitrogen, hydrogen, chlorine, fluorine, and, at times, sodium.) The reason for this emphasis is the growth of interest in combustion and atmospheric chemistry. Much of the activity has been mission-oriented. This

and the limitations imposed by deadlines have often led to superficial analyses, to the production of estimates for reactions for which no data exist, and codification in a form suitable only for the immediate purpose. One result is that the work ages rapidly.

The light-molecule reaction field is an unusual portion of kinetics. There are reactions for which many sets of data exist. Thus, the classic approach to evaluation is possible. Such a situation is the exception in the vastly larger field of gas phase reactions of organic molecules. There, it is uncommon for more than one study of the same reaction to have been made. It is more common for kineticists to study a series of related reactions and to draw from the results qualitative information about mechanisms and trends in rates. I suspect that this is the situation in other active research fields. This is a factor that should be borne in mind while considering what the usual review articles provide.

Review journals and series and textbooks are rarely good sources of rate evaluations. The lack of comparative data cited above, the press of time while writing a review, the obligation to cover a defined field (invariably too large), and a reluctance to go out on a limb contribute to the usual situation: A reviewer will summarize what is known, indicate agreement among the reports, but only rarely advocate a value.

Research articles, in principle, should be good sources for evaluations. Each author, according to the canons, is expected to place his new results in the context of the field of his research. Some do this well. Few, however, view the matter dispassionately and even fewer review all the pertinent related work.

Such a situation is unsatisfactory, particularly for the person who needs to apply rate data to analyze a system's performance. It accounts for the rash of mission-oriented rate analyses. These, in turn, indicate a failure on the part of kineticists to make their results available to the nonspecialist.

The need for improvement now is critical. One answer to the problem has been the development of Government-supported data compilation and evaluation programs. The

United States, the United Kingdom, and Soviet Russia all have programs for the evaluation of physical properties data. Those aspects closely related to chemical kinetics are described here. The U.S.A. program is considered at length, while the other two are treated only briefly, as the available information on them is limited.

1. *U.S.A.* The program of the NBS Office of Standard Reference Data in the area of Chemical Kinetics has two facets: The production of reviews on selected topics and the support of information analysis centers. Both gas phase and solution kinetics are included.

The reviews are not planned as current state-of-the-art surveys. They are planned as monographs that cover their topics exhaustively. They are expected to emphasize the re-analysis of data and either to present recommended values or to explain why this is not practical. The data on which the recommendations are based are to be tabulated, and an extensive bibliography is to be included; for example, see NSRDS-NBS 20, *Gas Phase Reaction Kinetics of Neutral Oxygen Species*¹ (49 pp; 45 cents).

The data centers supported by the Office of Standard Reference Data that are most closely related to kinetics are the NBS Chemical Kinetics Information Center, the Radiation Chemistry Data Center at Notre Dame University, and the JILA Information Center, Boulder, Colo. These three centers support the NSRDS review monograph program, develop bibliographies and compilations, and provide information to the public.

The information-for-the-public activity requires emphasis. Information analysis centers are no longer novelties, but the use of them is. The scientist who is starting a research project or planning to write a review should consider asking these centers to supply him with bibliographic information on his subject. To date the service has been used very little in the area of kinetics. The reason is not known, and more use is desirable, although even a modest increase in demand would swamp the Kinetics Center. However, that is a challenge we are willing to face.

2. *U.K.* The Office of Scientific and Technical Information is active in the field of kinetics. It supports a High Temperature Reaction Rate Data Group at The University, Leeds. This group has embarked on a program of rate evaluation in the light-molecule reaction field. Their first report presented evaluations of eight reactions of CO and CO₂. Additional evaluations of combustion reactions are in progress.

Another U.K. project should be mentioned. The Information Center on High Temperature Processes at Leeds regularly issues a *High Temperature Information Bulletin*. This is a current awareness service. It is particularly useful because it is arranged by subjects.

3. *U.S.S.R.* The State System of Standard Reference Data (GSSSD) has a program in the area of chemical kinetics. This is under the direction of V. N. Kondratiev. A major project is a multivolume work containing a complete review of the quantitative data on the kinetics of

chemical reactions—gas, liquid, and solid. Other GSSSD projects receiving emphasis are in the areas of thermodynamics and transport properties.

Professor Kondratiev has recently suggested that an international effort be mounted to encourage the publishing of rate data of standard reference quality. Possible steps in this direction are now being explored.

Certainly, there is the promise of major contributions to data evaluation in these three governmental programs. The pace at which they can move ahead is another matter. Probably all of them feel the effect of the competition between social and scientific activities for support.

The above discussion considered evaluations in general. When one turns his attention to the production of a specific evaluation, different problems must be considered. The most important are: How to extract the number; how to organize the report; and how best to distribute it. The impact of an evaluation depends upon the successful handling of all three. While all deserve considerable discussion, I shall limit my remarks to the easiest—the organization of the material. These remarks are in the form of suggestions to two groups of people—those who evaluate and those who support such work. The suggestions represent my opinion as to minimum acceptable standards for an evaluation.

The rough definition of a data evaluation given above does not include any quality standards. Nor does it prescribe how the material should be presented. Knowledgeable persons should be selected for the work. The material should be reviewed prior to publication. A sponsor's obligation is similar to that of the journal editor.

A good guide for the reviewer to follow is that a rate evaluation should be a source document. The reader should be able to use it as a starting point for assessing the importance and effect of *new* data on the evaluation. Ideally it should be unnecessary for him to rework the material assessed there. Although not all evaluations can fit the same pattern, some standardization is desirable. It will assist the user, whose approach almost always will be to look for the number and ignore the text. The problem has been stated to be that of producing "idiot-proof" tables. That is impossible, but the evaluator should give it some attention if he hopes to avoid being misquoted.

A few suggestions on organization of a rate evaluation, most of which are applicable to other types, are given below:

1. The evaluations of the forward and reverse rates for a system should be presented together.

2. The results of each research paper should be shown in a table. The applicable temperature ranges and limits of error should be included. Wherever possible, data points, not rate expressions, should be tabulated.

3. All tabulated results should be presented in consistent units. This may involve reworking the original data.

4. Each recommended rate expression should be accompanied by a value calculated for a common reference tem-

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NSRDS NEWS *continued*

perature. This "benchmark" provides an easy comparison point for the reader.

5. Both the research results and the recommended expression should be presented in a figure—as large as space and budget allow. Experience shows that such a graphical presentation is the most useful item a reader can be given. He can use it to assess the present work and to evaluate the impact of new data.

6. A discussion is necessary. It should explain the basis for developing the recommended value. It should summarize the research papers. It should indicate clearly which results were used and which were rejected, and tell why. It is difficult to think of a more useful service than this. An evaluator can and will prune out the deadwood, but unless he tells the reader about it the next man will be condemned to repeat the process.

7. A strict discipline should be maintained on the bibliographic material. It is very easy to make mistakes here. If A's work is known from B's summary or re-analysis, cite B not A. Otherwise the data chain is broken. It is also very useful to cross-reference references to indicate identical data, a sequence of developments, and so forth. Arguments can be made for including all pertinent papers examined. This is feasible if the number of papers is small, and is useful only if the author clearly marks the material not used (or not usable).

Organizational Changes in NBS Information Activities

The National Bureau of Standards has reorganized its technical and public information programs. Under the information reorganization, all the major units that gather, analyze, publish, and distribute scientific and technical information have been combined under an Associate Director for Information Programs.

Edward Brady, formerly Chief of the NBS Office of Standard Reference Data, is the new Associate Director. With this change, the Office of Standard Reference Data, the Clearinghouse for Federal Scientific and Technical Information, the Office of Technical Information and Publications, the Library Division, the Office of Public Information, and the Office of International Relations, will be under Dr. Brady.

Centralized management of these related activities will provide better coordination among them and will facilitate the introduction of systems concepts and rapidly advancing techniques for data processing. The effectiveness with which scientific and technical advances are utilized is largely dependent on the effectiveness with which information about new developments becomes incorporated into the working knowledge of the individual scientist or engineer. NBS has responsibility for seeing that its own scientific information is disseminated with the maximum effectiveness, and through such programs as NSRDS and

the Clearinghouse, has government-wide responsibilities in information and technology transfer.

David R. Lide, Jr., formerly Chief of the Bureau's Infrared and Microwave Spectroscopy Section of the Atomic Physics Division, succeeds Dr. Brady as Chief of the Office of Standard Reference Data. Dr. Lide was the 1968 recipient of the Bureau's Samuel W. Stratton Award.

CODATA Newsletter

The International Council of Scientific Union's Committee on Data for Science and Technology has begun a newsletter. The first issue of the *CODATA Newsletter* is dated October 1968. It contains a background article by F. D. Rossini, President of CODATA, on the history, present status, and future developments of international activities in the evaluation of scientific and technological data. Also included are descriptions by Guy Waddington, Director, Office of Critical Tables, of the reorganization and activities of CODATA, and the First International CODATA Conference. The *CODATA Newsletter* is free and may be obtained from Dr. Christoph Schäfer, Executive Director, Central Office of CODATA, Westendstrasse 19, 6 Frankfurt/Main, Germany—BRD.

New AMPIC Bibliography

ORNL-AMPIC-11, Bibliography of Atomic and Molecular Processes for January-June 1968,² is the ninth in a series of bibliographies published by the Atomic and Molecular Processes Information Center (AMPIC) at Oak Ridge National Laboratory. The Center is jointly sponsored by the U.S. Atomic Energy Commission and the NBS Office of Standard Reference Data. This annotated bibliography contains references of interest to atomic and molecular processes research. Bibliographic sources consist of 80 scientific journals and 5 abstract journals. As in the previous bibliographies of this series, references are classified into 14 major categories with appropriate subcategories, and are entered alphabetically in each category according to the reactants or the atomic and molecular system of interest.

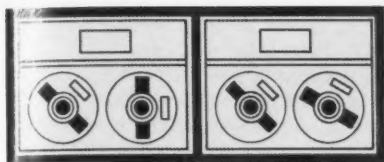
Scientific Translations

The European Translation Center³ of Delft, Netherlands, has begun to publish quarterly a cumulative *World Index* citing all non-western scientific and technical translations in all western languages. *The European Translation World Index* gives information regarding the availability of about 20 000 articles translated each year and provides an effective means for checking whether or not a western language translation has been undertaken or is in progress.

¹ Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

² Available from the Atomic and Molecular Processes Information Center, Oak Ridge National Laboratory, P. O. Box Y, Oak Ridge, Tenn. 37831. Doelenstraat 101, Delft, Netherlands.

³ Subscription cost is \$25 a year from the European Translation Center.



Information Processing

In the fall of 1965 the Secretary of Commerce established the NBS Center for Computer Sciences and Technology to carry out the Secretary's responsibilities under the Brooks Bill (Public Law 89-306, passed October 30, 1965). The Center, under the direction of H. R. J. Grosch, provides leadership and coordination for government efforts in the development of voluntary commercial information processing standards, develops recommendations for Federal information processing standards, performs required research and analysis, and provides scientific and technical support and consultative assistance in the field of computers and information processing to Federal agencies. This column will cover information-processing standards activities in the Federal Government, particularly those of the Center.

FEDERAL INFORMATION PROCESSING STANDARDS REGISTER

The National Bureau of Standards has issued the first seven publications in the Federal Information Processing Standards Publications (FIPS PUB) Series. This series is the official publication medium within the Federal Government for information relating to standards that are adopted and promulgated under the provisions of (1) Public Law 89-306 (the Brooks bill), an act that provides for the economic and efficient purchase, lease, maintenance, operation, and utilization of automatic data processing equipment in Federal departments and agencies; and (2) Bureau of the Budget Circular A-86 entitled "Standardization of Data Elements and Codes in Data Systems." The publications in this series collectively constitute the Federal Information Processing Standards Register. The standards in the series are classified into four major categories—hardware, software, applications, and data.

The Center for Computer Sciences and Technology has assigned Harry S. White, of the Center's Office of Information Processing Standards, the responsibility of developing and maintaining the FIPS Register.

The First Seven FIPS PUBS

FIPS PUB 0, *General Description of Federal Information Processing Standards Register*¹ (8 pp., 20 cents), defines the responsibilities for the Register and its contents and categories of standards; it also suggests a method for establishing and maintaining standards within an activity.

FIPS PUB 1, *Code for Information Interchange*¹ (4 pp.; 10 cents), provides administrative, policy, and

guidance information relative to the implementation and utilization of the standard code for information interchange.

FIPS PUB 2, *Perforated Tape Code for Information Interchange*¹ (4 pp.; 10 cents), provides administrative, policy, and guidance information pertaining to the implementation and utilization of the standard perforated tape code for information interchange.

FIPS PUB 3, *Recorded Magnetic Tape for Information Interchange* (800 CPI, NRZI)¹ (4 pp.; 10 cents), provides administrative, policy, and guidance information relative to the implementation and utilization of the standard magnetic tape (800 characters per inch, NRZI—non-return-to-zero-change to one—method of recording) for information interchange.

FIPS PUB 4, *Calendar Date*¹ (4 pp.; 20 cents), announces the adoption of a Federal standard for representing calendar dates used in the interchange of formatted machine-sensible coded data between and among agencies. The technical specifications (FIPS 4) are affixed to the FIPS PUB.

FIPS PUB 5, *States of the United States*¹ (4 pp.; 20 cents), announces a standard identification and code for representing the 50 States, the District of Columbia, and the outlying areas of the United States, all of which are considered to be "first order subdivisions." These codes are for use in the interchange of formatted machine-sensible coded data between and among agencies. The technical specifications of the standard (FIPS 5) are affixed to the FIPS PUB.

FIPS PUB 6, *Counties of the States of the United States*¹ (32 pp.; 40 cents), announces a standard identification and code for representing the counties of the 50 States of the United States for use in the interchange of formatted machine-sensible coded data between and among agencies. Also included are the independent cities of the States of Maryland, Missouri, and Virginia, which are treated as county equivalents. The technical specifications of the standard (FIPS 6) are affixed to the FIPS PUB.

In some cases the technical specification of the standards are not affixed to the FIPS PUBS, as in the cases of FIPS PUB 1, 2, and 3. The technical specifications of these three standards may be obtained in the following manner: (1) Federal Government agencies should purchase from the General Services Administration, Specifications Activity, Printed Materials Supply Division, Building 197, Naval Weapons Plant, Washington, D.C. 20402. Refer to FIPS 1, 40 cents; FIPS 2, 45 cents; and FIPS 3, 70 cents. (2)

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INFORMATION PROCESSING *continued*

Others should obtain copies from the United States of America Standards Institute, 10 East 40th Street, New York, N.Y. 10016. Refer to USA Standards X3.4-1968, \$2.00; X3.6-1965, \$1.50; and X3.22-1967, \$2.50, for FIPS 1, 2, and 3, respectively.²

All FIPS PUBS are available for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 for the prices indicated. There is a 25 percent discount on quantities of 100 or more.

FIPS PUBS are also available on a subscription basis from the Superintendent of Documents. Cost for an indefinite period (12 to 18 months) is: domestic—\$12; foreign—\$15. New subscribers will receive all previous publications in the series and subsequent issues until the subscription price is expended. Renewal notices will be sent at that time.

Notifications of new publications in the series may be obtained from the Superintendent of Documents. Refer to Notifications Key N-377.

A current list of all FIPS PUB's may be obtained from the NBS Office of Technical Information and Publications, Washington, D.C. 20234. Also, all new FIPS PUB's will be announced in the *Technical News Bulletin*.

COBOL TO BE A FEDERAL STANDARD

Approximately 100 representatives of component manufacturers, software producers, private industry users, Federal users, and the technical press met at NBS on December 16, 1968. The meeting, chaired by H. R. J. Grosch, Director of the NBS Center for Computer Sciences and Technology, was called to review the forthcoming adoption of USASI Standard COBOL (X3.23-1968) as a Federal Information Processing Standard. It was pointed out that the Federal Government represents approximately 10 percent of the total ADP market and that this has substantial effects on both domestic and international marketing situations. This meeting was an effort to reduce the possibilities of conflicts when COBOL is promulgated as a Federal Standard.

The discussion brought out the following: That pre-processors will be involved; that fewer levels would be preferred; that insufficient experience is available with the new standard; that there is disagreement on what "floors" and "ceilings" should be; and that better definitions of "interchange" should be available. The next steps in the Federal standardization process will be to write and circulate a proposal document to the various Federal departments and agencies for comment.

OCR TYPEWRITER RIBBON STUDY

Technical work on OCR (Optical Character Recognition) typewriter ribbons has been completed by the Center for Computer Sciences and Technology. The Center's recommendations have been forwarded to the GSA Fed-

eral Supply Service for GSA's use in preparing a Federal Specification for OCR Typewriter Ribbons.

OCR reading devices view typewritten images serially in very small areas in contrast to the larger area seen by the human eye. This makes it necessary to measure line thickness as well as imprint density in evaluating typewriter ribbons; consequently, the traditional cross-hatched pattern test for optical density cannot be used. One-time polyethylene-base typewriter ribbon is the only category of material covered by this study. Equipment, test methods, and gages are specified in the recommendations.

MAGNETIC DISK COMMITTEE INVITES MEMBERSHIP

USASI Committee X3.2.5 has been established to standardize the elements involved in recording information on magnetic disks and the interchange thereof including labels and record formats. Federal agencies interested in participating may contact Philip S. Johnson, NBS Office of Information Processing Standards, Rm. B264, Instrumentation Bldg., Washington, D.C. 20234.

JOVIAL PROGRAMING LANGUAGE

A new USASI working group X3.2E, Jovial Programming Language, has been formed to investigate possible standardization of the JOVIAL programming language. The group will be chaired by A. R. Sorokowitz, Naval Command Systems Support Activity, Code 21, Building 196, Washington Navy Yard, Washington, D.C. 20390. The first meeting was held March 7, 1969, at BEMA, 235 East 42d St., New York, N.Y. Federal agencies who are interested should contact Mr. Sorokowitz for further information.

CODE TRANSITION COMMITTEE

A USASI working group, X3.2F, has been organized as the Committee on Problems Associated with the Transition from Codes Currently in Use to USASCII (USA Standard Code for Information Interchange). It will study the possible difficulties facing the information processing and communications industries during changeover to the new standard and develop suggested user practices. Current and target environments will be identified so that problem areas can be discerned.

The target standard information processing and communications environment will include: USA Standard Code for Information Interchange; media—magnetic tape, punched cards, magnetic disk, OCR, and MICR; programming languages; magnetic tape labels; data elements, codes, and formats; input/output interfaces; message procedures of framing, or character structure; data descriptive language; operating system control language; device keyboards; collating sequence; and code extension or expansion.

Interested agencies should contact J. L. Little, NBS Office of Information Processing Standards, Rm. B253, Instrumentation Bldg., Washington, D.C. 20234.

INTERAGENCY TASK GROUPS PLANNED

Four interagency task groups on Transition to Federal ADP Standards were established as a part of the Interagency Committee on ADP. These groups were organized in response to recommendations of an ad hoc Policy Group established by a meeting of Federal ADP representatives on July 30, 1968. The groups are:

Group 1 *Definition of Federal ADP standards objectives and requirements.* Briefly, Group 1 will assist in translating the very general objectives of Public Law 89-306 into specific objectives and requirements for uniform Federal ADP standards.

Group 2 *Recommendations on standard control procedures and header formats for remote computer terminals.* Group 2 will examine the control and procedural requirements of commercial remote computer terminal devices as well as the interface relationships to the NCS system with the objective of providing standardization guidance.

Group 3 *Recommendations on ASCII character subsets, algebraic sign conventions, and packing conventions.* Group 3 will direct its attention to uniformity in implementing character subsets of ASCII, conventions for algebraic sign in data input/output, and processing and conventions for packing data. An example of packing is packed numeric data on magnetic tape.

Group 4 *Preparations of subsections for uniform implementation of approved Federal ADP standards for inclusion in requests for proposals.* Group 4 will direct its attention to the drafting of subsections suitable for inclusion in a Request for Proposal (RFP). This work will contribute to uniformity of implementation and compliance with Federal ADP standards.

It was also recommended that task group chairmen work for a systems approach to ADP standards guidance and development.

H. R. J. Grosch reviewed this program at the September 10, 1968, meeting of the Interagency Committee on ADP. Federal departments and agencies are requested to participate in the work of these four groups. Further information is available from L. L. Griffin, NBS Office for Information Processing Standards, Rm. B262, Instrumentation Bldg., Washington, D.C. 20234.

Status of Federal Information Processing Standards Recommendations

First Phase: PROJECT NOMINATION

- Interchangeable Magnetic Disk Media
- Glossary of ADP Terms
- Magnetic Tape Measurement Techniques
- Time Sharing and Remote Console Considerations
- RFP, RFQ, and Contract Formats
- Hardware Interfaces
- Keyboard Configuration
- OCR Measurement Technology
- OCR Paper
- Signal Quality
- Character Structure and Parity Sense
- Synchronous Signalling Speeds
- ADP Systems Site Preparation

Second Phase: STANDARDS DEVELOPMENT

- Magnetic Tape Labels for Information Interchange
- Hollerith Punched Card Code
- FORTRAN Standard Reference
- COBOL Programming Language
- OCR Character Set
- Recorded Magnetic Tape for Information Interchange (200 CPI NRZI)

Layout of Forms for OCR Input

Third Phase: RECOMMENDATION FOR ADOPTION

None

Fourth Phase: ISSUED FEDERAL STANDARDS

- FIPS 1 Code for Information Interchange
- FIPS 2 Perforated Tape Code for Information Interchange
- FIPS 3 Recorded Magnetic Tape for Information Interchange
- FIPS 4 Calendar Date
- FIPS 5 States of the United States
- FIPS 6 Counties of the States of the United States

¹ Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

² The prices given here for direct purchase from the USASI are single-copy prices. Quantity discounts are available on larger orders from USASI. The prices charged Federal Government agencies by GSA reflect the large-quantity rates made available to GSA by USASI.

CONFERENCE & PUBLICATION *Briefs*

SEMINAR ON DURABILITY OF INSULATING GLASS

The National Bureau of Standards, the American Society for Testing and Materials, the Construction Specifications Institute, Inc., and The Building Research Institute were cosponsors of a seminar on the Durability of Insulating Glass held November 14 and 15, 1968, at the Bureau's facilities in Gaithersburg, Md. The conference was specifically designed to bring together people con-

cerned with the design, manufacture, testing, specification, purchase, installation, or maintenance of windows for the purpose of exchanging information that could lead to better insulating-glass performance. The seminar was coordinated by R. W. McKinley of PPG Industries, representing ASTM Committee E-6, and by H. E. Robinson of the NBS Building Research Division.

Insulating glass units in windows provide building occupants with increased thermal comfort, better hu-

continued

BRIEFS *continued*

midity control, reduced noise, and enhanced privacy. Reliable insulating glass assists materially in the economical heating and cooling of buildings and usually results in reduced maintenance costs. At present more than 75 American and 25 Canadian firms manufacture insulating glass units, and from all indications their use will continue to increase.

The seminar's technical program consisted of individual papers and 3 panel discussions. Following each panel discussion, an open forum with questions from the floor was held.

The first talk was presented by A. G. Wilson, National Research Council, Canada. He described the rapid growth of factory-sealed double-glazed units in Canadian construction and the development of test methods for their evaluation. As a result of these tests, he said, a steady improvement in the quality of many of the units has occurred.

Following this talk, Tore Gjelsvik, Norwegian Building Research Institute, described Norwegian experience with sealed glazing units during the last ten years. Systematic field studies, he said, have been carried out in parallel with laboratory work to check accelerated aging tests. One field study of 2040 units, some of which had been installed as far back as 1951, was conducted with good correlation between the field study and laboratory accelerated-weathering tests.

The first panel discussion dealt with the need for reliability and durability of insulating glass. It was pointed out that a need exists for information on the saving afforded by insulating glass in heating and cooling losses as an offset to the original cost of installation. Another subject discussed was the architect's, manufacturer's, and contractor's responsibilities in this field. It was also pointed out that methods for evaluating insulating-glass performance are needed to aid in selecting suitable units.

The second panel discussion covered manufacturers' test methods, correlation with field experience, and expected life service of insulating-glass units. In this session test methods currently used at Libby-Owens-Ford Glass Co., PPG Industries, Tremco Manufacturing Co., and Products Research Corp. were presented. The requirements of sealants were also covered in this session.

Following the panel discussions on November 14, a review of current practices leading to new test methods and standards was the subject of a paper by H. E. Robinson, NBS. He also presented recommendations based on the review, and outlined a suggested testing apparatus.

On Friday, November 15, the sessions were concluded with a panel discussion in which proposals for future action was the topic. One proposal was that the Durability Task Group of Subcommittee VIII, ASTM Committee E-6, plan and conduct a round-robin program of test method comparisons. Such a round-robin procedure, it was felt,



J. R. Wright, Chief of the Building Research Division, welcomes attendees at the Seminar on Durability of Insulating Glass.

would lead to improved test methods and in turn would result in greater reliability of insulating-glass units.

Another proposal was for recognition of immediate and future needs for cooperative use of available testing methods for improving the quality of procured sealed insulating-glass units, on the part of the Government, producers, and general users. The view was expressed that joint action on the part of the industry, and of ASTM and the Government, would be desirable in the near future. Avenues to cooperation for development of improved test methods, such as a Research Associateship at the National Bureau of Standards, were also described.

The final session speaker, C. C. Stout of the Andersen Corp., presented information based on many years of experience in regard to the good durability of carefully-procured insulating-glass units, and expressed the view that value, not price, was the hallmark of accomplishment and future progress in the insulating-glass industry.

NATURAL PRODUCTS SYMPOSIUM

Ever since man ventured into the sea he has been plagued by the attachment of marine organisms to his vessels. The fact that marine organisms (and the barnacle in particular) are so difficult to remove has caused scientists to examine the substances by which the organisms are attached and held fast to almost all immersed objects. The "cement" of a giant barnacle, the *Balanus nubilus*, was one of the natural products discussed recently at a Symposium on Natural Products. Sponsored by the Chemical Society of Washington and the National Bureau of Standards, the meeting was held December 12, 1968, at the NBS facilities in Gaithersburg, Md. Alfred H. Ellison, of the Gillette Research Institute, served as General Chair-

man; Anthony M. Schwartz, also of the Gillette Research Institute, served as Program Chairman.

In the opening session, entitled Marine Biological Adhesives, the nature and properties of barnacle cementum were described by N. F. Cardarelli of the University of Akron. He postulated that, as an inert adhesive with a bond strength of great magnitude, the material could be of considerable usefulness to medical science as a bone cement and to dental science as a dental restorative.

The Symposium's second speaker, N. J. Leonard of the University of Illinois, related the findings of his investigations on the chemistry of cytokinins (substances that play a major role in plant growth) and delineated the requirements for cytokinin activity.

John C. Sheehan of the Massachusetts Institute of Technology spoke at the third session on Macrocyclic Peptides. Such peptides are a class of macromolecules to which many antibiotics belong. Using a common antibiotic, Dr. Sheehan illustrated the use of modern techniques in determining the structure of macrocyclic peptides.

The chemical and biological changes that occur in irradiated food components were then discussed by Jack Schubert of the University of Pittsburgh. He described how, under certain irradiation conditions, food components (such as carbohydrates or amino acids) will produce toxic or mutagenic compounds.

The recent increased use, and subsequent large-scale production, of therapeutically important steroids, requires that the multistep processes in their production be carefully controlled. Byron Riegel of G. D. Searle and Co. highlighted the steps in the production of synthetic steroid drugs. The principal starting material for these steroids is dioscin from a natural product called Barbasco root.

The program closed with a session entitled Arene Oxides as Intermediates in the Metabolism of Aromatic Substrates. On this topic, Bernhard Witkop of the National Institutes of Health presented evidence to support the view that the nature of intermediates involved in the "NIH Shift" is better expressed through arene oxides.

SCHEDULED NBS-SPONSORED CONFERENCES

Each year NBS sponsors a number of conferences covering a broad range of topics in science and technology. The conferences listed below are either sponsored or co-sponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. If no other address is given, inquiries should be sent to the person indicated below in care of Special Activities Section, Room A600, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

Fundamental Aspects of Dislocation Theory. Apr. 21-25. Contact: J. Simmons (NBS Metallurgy Division).

NRCA-NBS Joint Symposium on Roofing. Apr. 29-30. Cosponsor: National Roofing Contractors Association. Contact: T. H. Boone (NBS Bldg. Res. Div.).

Symposium on Health Problems. May 14-16. Cosponsor: Operations Research Society of America (Health Section). Contact: Lloyd Burden (NBS Technical Analysis Division).

10th Symposium on Electron, Ion, and Laser Beam Technology. May 21-24. Cosponsors: University of Maryland, Institute for Electrical and Electronics Engineers (GED), American Vacuum Society. Contact: L. Marton (NBS).

Symposium on Systems Analysis for Social Problems. May 26-28. Cosponsors: Washington Operations Research Council, President's Office of Science and Technology, The Urban Institute, Operations Research Society of America (Cost-Effectiveness Section). Contact: Eugene P. Visco, GEOMET, Inc., 12280 Wilkens Ave., Rockville, Md. 20852.

Conference on Crystal Growth. Aug. 11-13. Sponsor: American Committee for Crystal Growth. Contact: C. S. Sahagian, Air Force Cambridge Research Laboratories, L. G. Hanscom Field, Bedford, Mass. 01730.

Dental Research—50th Anniversary. Oct. 6-8. Cosponsor: American Dental Association. Contact: W. T. Sweeney (NBS Polymers Division).

3d Materials Research Symposium—Electronic Density of States. Nov. 3-6. Contact: H. C. Burnett (NBS Metallurgy Division).

NBS Measurement Seminars and Workshops 1968-1969. Two- to five-day courses on measurement and calibration problems. Attendance limited. See October 1968 *Technical News Bulletin* for detailed information.

Seminar Date Changed

The NBS seminar on High Frequency and Microwave Power, originally scheduled at the NBS laboratories in Boulder for March 26-28, will instead be held April 14-16. The fee is \$225. Apply to: Paul A. Hudson, NBS Radio Standards Engineering Division, Boulder, Colo. 80302. (The seminar was described in the October 1968 *Technical News Bulletin*.)

1968 TECHNICAL HIGHLIGHTS

The 1968 Technical Highlights of the National Bureau of Standards,¹ NBS Special Publication 308 (211 pp.;

¹ Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

continued

BRIEFS *continued*

\$1), is a survey of the Bureau's activities from July 1, 1967, to June 30, 1968. It covers extensive in-house research activities, relations with other U.S. Government agencies, industry, and science, and participation in international efforts to coordinate and advance physical measurements and standards.

An introductory chapter reports organizational changes and describes the Bureau's Research Associate and Foreign Scientist Visitation programs. Laws and legislative proposals affecting the Bureau are also discussed. Two key programs, the National Standard Reference Data System and the Standard Reference Materials Program, are the subjects of a special feature. The history of each program is traced and a synopsis given of current activities.

The main body of the report deals with significant scientific and technical accomplishments during the fiscal year. Brief mention is made of a variety of developments and experiments. They include:

- Studies of a helium-neon laser that may lead to a more accurate standard of length measurement

- Investigation of improved methods of time and frequency dissemination using satellites

- Fabrication of a detector for studying cracking in metals caused by vibration—important in the design of aircraft and space systems

- Evaluation of camera lenses for color aerial photography used in such diverse applications as agriculture, geological surveys, mapping and military reconnaissance

- A study of noise in multifamily housing and the publication of an extensive report on the subject for use by engineers developing better sound insulating materials

- Tests of the fluorescence of various materials used by hunters to identify them in the field

- Procedures for testing the susceptibility of microfilm to blemish formation and other degradation that obliterates useful and often valuable information contained on the film

- Installation of an advanced neutron generating facility for a variety of nuclear studies including shielding of neutrons and gamma rays

- A new polymeric material that can be used as a surgical splint for jaw fractures. The doughlike material hardens quickly after being applied to the injured area and is especially useful for treating combat injuries

- A study of the corrosion of iron by bacteria

- Measurement of the dielectric (electrical insulating) properties of foliage, for use by researchers interested in the effects of foliage on radio waves, and especially useful to Navy scientists attempting to solve communications problems in Vietnam

- Analysis of the eyebar that initiated the collapse of the highway bridge at Point Pleasant, W. Va., killing 46 and injuring many others

Reduction (by an estimated \$5 million) of the damages caused by the August 1967 flood in Fairbanks, Alaska. Two Bureau engineers were sent to Alaska to provide firsthand advice and assistance to stricken residents

A procedure for determining by computer whether two fingerprint impressions were made by the same finger

Technical assistance to the Department of Housing and Urban Development to determine whether quick and inexpensive application of systems analysis to selected city problems is feasible

Expansion of flammable fabrics research to include items of interior furnishings in addition to wearing apparel

Operation of the NBS Reactor—a 10-million-watt facility being used in materials research experiments after nine years of planning and construction.

A series of appendices summarizes the organization and finances of NBS. It also lists the year's publications and patents by NBS staff members.

MATRIX REPRESENTATIONS OF GROUPS

The mathematical theory of group representations is of fundamental importance in such scientific disciplines as particle physics and crystallography, and has been a major force in group theory. Because of this wide use, a need has long existed for a simple, but complete, exposition on the subject. This publication, *Matrix Representations of Groups*, NBS Applied Mathematics Series 60¹ (79 pp.; 60 cents), has been prepared to answer that need.

SELECTED NBS PAPERS ON TEMPERATURE

Although designated Volume 2 (513 pp.; \$4.75) of NBS Special Publication 300,¹ *Precision Measurement and Calibration* is actually the first in a series that will bring together previously published writings by NBS authors dealing with precision measurement of specific physical quantities and the calibration of the related metrology equipment. The present volume, a compilation of reprints on temperature measurement and calibration through June 1967, is organized in a manner typical of that to be followed in the other volumes. It begins with a summary of recommended practice for the expression of uncertainties and then discusses the various aspects of precise temperature determination, grouping the material under the headings: Temperature Scales, Resistance Thermometry, Thermoelectric Thermometry, Liquid-in-Glass Thermometry, and Spectroscopic Thermometry. This is followed by a selected but extensive bibliography of temperature measurement from January 1953 to December 1965, and by subject and author indices.

Volumes on Statistical Concepts and Procedures (Vol. 1) and on Electricity—Low Frequency (Vol. 3) are now in press.

PUBLICATIONS of the National Bureau of Standards*

PERIODICALS

Technical News Bulletin, Volume 53, No. 2, February 1969, 30 cents. Annual subscription: Domestic, \$3; foreign, \$4. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, \$6; foreign, \$7.25. Single copy, \$1.

Section B. Mathematical Sciences. Issued quarterly. Annual subscription: Domestic, \$2.25; foreign, \$2.75. Single copy, 75 cents.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, \$2.75; foreign, \$3.50. Single copy, 75 cents.

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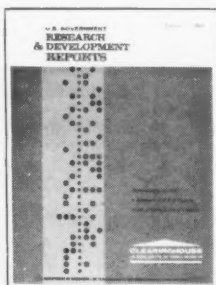
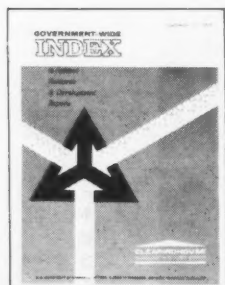
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